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# (54) Production of whole milk substitutes

(57) A method of preparing a dry whole milk substitute suitable for young farm animals, comprises adding from 0.4 to 0.6% by volume of acidophilic bacteria to pasteurised whey and fermenting the whey at a temperature of from 37° to 39°C, adding from 1.5 to 2.5% by volume of propionic acid bacteria and further fermenting the whey at a temperature of from 30° to 32°C, neutralising the fermented whey, mixing the neutralised whey with a condensed milk base and a fat base containing fat-soluble vitamins, and homogenising and drying the mixture.

GB 2 170 984 A

SPECIFICATION

## Method of preparing whole milk substitutes

The present invention is concerned with a method for the preparation of whole milk substitutes suitable for young farm animals.

One of the ways by which certain raw materials can be used to advantage and the output of commercial milk increased is to use whole milk substitutes for feeding young farm animals.

Whole milk substitutes are multi-component compositions whose formulations are close to that of the natural milk of farm animals. Controlled formulation of these compositions makes it possible to produce whole milk substitutes with predetermined functional properties.

An important raw material source for the production of whole milk substitutes is whey; by using whey as a replacement raw material, it is possible to save skim milk which is a valuable starting material for the manufacture of a number of other foodstuffs.

One of the factors limiting the use of whey as a foodstuff is that about 70% of its dry solids consist of lactose which is poorly assimilated by young animals. However, whey lactose serves as a good substrate for the growth of numerous species of microorganisms which can produce biologically active substances. For example, on this substrate the acidophilic bacteria *Lactobacillus acidophilus* produces substances having antagonistic properties towards some pathogenic microorganisms. Acidophilic bacteria can survive in the gastrointestinal tract of animals, where they sustain the intestinal microflora and improve the efficiency of the digestive system. Live cells of acidophilic bacteria are also able to restore intestinal microflora which have been affected by the administration of therapeutic preparations with a broad range of activity which attack not only pathogenic bacteria, but useful microorganisms as well, thereby producing disbacterioses. Thus foodstuffs containing live cells of acidophilic bacteria are prophylactic and therapeutic agents for the prevention and treatment of gastrointestinal diseases in animals.

Other microorganisms produce vitamins. For example, propionic acid bacteria produce vitamin $B_{12}$, a vitamin which is usually incorporated in whole milk substitutes in order to improve the metabolic efficiency of animals and promote growth. A dietary shortage of vitamin $b_12$ disturbs the metabolism of carbohydrates and proteins and leads to homopoiesis, a condition which causes diseases and reduced froductivity in animals.

We have now developed a method of preparing a whole milk substitute suitable for young farm animals which uses whey as the raw material and gives a product containing live cells of acidophilic bacteria and vitamin $B_{12}$.

According to the present invention, therefore, there is provided a method of preparing a dry whole milk substitute suitable for young farm animals, which comprises adding from 0.4 to 0.6% by volume of acidophilic bacteria to pasteurised whey and fermenting the whey at a temperature of from 37° to 39°C, adding from 1.5 to 2.5% by volume of propionic acid bacteria and further fermenting the whey at a temperature of from 30° to 32°C, neutralising the fermented whey, mixing the neutralised whey with a condensed milk base and a fat base containing fat-soluble vitamins, and homogenising and drying the mixture.

Suitable milk bases include, for example, condensed skim milk or a condensed mixture of skim milk and up to 25% by weight of buttermilk. Suitable fat bases include, for example, bone fat, confectionery fat, or cooking fat, to which emulsifiers, such as phosphatide concentrates, sodium caseinate or distilled monoglycerides, have been added.

During fermentation of the whey, the acidophilic bacteria produce lactic acid which is then consumed by the propionic acid bacteria. After an incubation period of 3 hours, the acidophilic bacteria start to multiply and the pH of the fermentation mixture falls to 5.7 to 5.9 due to the formation of lactic acid. By the fifth hour, the pH has fallen to 5.2 to 5.4; still lower pHs cause inhibition of the growth of the propionic acid bacteria, such as *Propionobacterium shermanii*. The use of less than 0.5% by volume of the acidophilic bacteria, such as *Lactobacillus acidophilus*, reduces the antibiotic activity of the fermented whey, while the use of more than 0.6% by volume of the acidophilic bacteria inhibits the growth of the subsequently added propionic acid bacteria. If the amount of the latter used is less than 1.5% by volume, the rate of formation of vitamin $B_{12}$ is undesirably reduced, while the use of more than 2.5% by volume reduces the antibiotic activity of the final product.

By using an amount of acidophilic bacteria which is less than the amount of propionic acid bacteria, domination of the fermentation by the acidophilic bacteria, which have a faster growth rate than propionic acid bacteria, is avoided. In order to reduce the volume of the fermentation mixture, the whey is preferably condensed, for example to a dry solids content of 15 to 20% by weight, prior to fermentation.

The method of the invention does not require the use of any special equipment and gives a final product which typically contains 25 to 25% of high quality proteins derived from milk, 16 to 20% of fats, and vitamins. One gram of the dry final product typically contains 5 to 8 million live cells of acidophilic bacteria and 4 to 6$\mu$g of vitamin $B_{12}$. The importance of acidophilic bacteria and vitamin $B_{12}$

in the diet of young farm animals has been referred to above. The product is also highly soluble in water.

A preferred procedure for carrying out the method of the invention will now be described in greater detail.

The whey is first pasteurised by conventional techniques at a temperature of 62-65°C for 30 minutes or at a temperature of 70-72°C for 15 seconds, and is then cooled to a temperature of 37-39°C. To promote the growth of the microorganisms, 1-2% of corn extract or another growth stimulant may be added to the whey prior to pasteurisation. 0.0025% of cobalt chloride is added (alternatively the cobalt chloride can be added prior to pasteurisation), the pH of the medium is adjusted to 6.3-6.5, and 0.4-0.6% by volume of a culture of acidophilic bacteria is added. Alternatively, the culture may be added to whey which has been condensed to a dry solids content of 15-20% by weight. In both cases, after 3-5 hours' growth of the acidophilic bacteria, 1.5-2.5% by volume of a culture of propionic acid bacteria is added and the mixture of microorganisms is cultured for 20 to 22 hours at a temperature of 30-32°C. The resultant fermented whey is then neutralised and mixed with a milk base and a fat base. The preferred milk base is skim milk which has been condensed to a dry solids content of 34-55° by weight. Up to 25° by weight of the skim milk may be replaced with buttermilk. The fat base is prepared by adding emulsifiers to melted fat; suitable emulsifiers include phosphatide concentrates, sodium caseinate, or distilled monoglycerides; vitamins A and D may also be added. The resulting fat base is thoroughly agitated until the components are completely dissolved, mixed with the milk base, homogenised, mixed with the fermented whey, homogenised, and then dried. Alternatively, a mixture of the milk base, the fat base and the fermented whey may be homogenised and dried.

In order that the invention may be more fully understood, the following examples are given by way of illustration only.

*Example 1*

To produce 1 tonne of whole milk substitute, 1460 kg of whey to which 15.6 kg of corn extract and 0.036 kg of cobalt chloride had been added was pasteurised at a temperature of 65°C for 30 minutes, then cooled to a temperature of 37°C. The pH of the mixture was adjusted to 6.3 and 0.5% by volume of starter culture *(L. acidophilus)* was added. After 4 hours, 2.0% by volume of a culture of propionic acid bacteria, *P. shermanii*, was added.

The mixture of microorganisms was cultured for 21 hours at a temperature of 30°C. The pH of the fermented whey was adjusted to 6.8. The milk base was prepared by condensing 8070 kg of skim milk in a vacuum evaporation unit to a dry solids content of 40% by weight. The fat base was prepared by adding 12 kg of phosphatide concentrates, 5.0 kg of distilled monoglycerides, 0.1 kg of a preparation of vitamin A, and 0.05 kg of a preparation of vitamin D to 160 kg of melted fat. The resulting fat base was thoroughly agitated until the components were completely dissolved, mixed with the milk base, homogenised, mixed with the fermented whey, homogenised, and then spray dried.

The dry whole milk substitute was a fine powder of uniform composition. the solubility index expressed in ml of a wet residue did not exceed 0.8. One gram of the dry product contained $6 \times 10^6$ live cells of acidophilic bacteria and 5 $\mu$g of vitamin $B_{12}$.

*Example 2*

To produce 1 tonne of whole milk substitute, 1460 kg of whey to which 0.036 kg of cobalt chloride had been added was pasteurised at a temperature of 70°C for 15 seconds, then cooled to a temperature of 38°C. The pH of the mixture was adjusted to 6.5 and 0.6% by volume of starter culture *(L. acidophilus)* was added. After 5 hours, 2.5% by volume of a culture of propionic acid bacteria was added.

The mixture of microorganisms was cultured for 22 hours at a temperature of 32°C. The pH of the fermented whey was adjusted to 7.0. The milk base was prepared by condensing 2017.5 kg of buttermilk and 6052.5 kg of skim milk in a vacuum evaporation unit to a dry solids content of 45% by weight. The fat base was prepared by adding 40 kg of a 25% solution by weight of sodium caseinate in skim milk, 0.1 kg of a preparation of vitamin A, and 0.05 kg of a preparation of vitamin D to 200 kg of melted fat. The milk base and fat base were thoroughly mixed and then added to the fermented whey; the resulting mixture was homogenised and then spray dried.

The dry whole milk substitute was a powder of uniform composition; the solubility index expressed in ml of a wet residue did not exceed 0.8. One gram of the dry product contained $8 \times 10^6$ live cells of acidophilic bacteria and 4 $\mu$g of vitamin $B_{12}$.

*Example 3*

To produce 1 tonne of whole milk substitute, 1270 kg of whey was condensed to a dry solids content of 15% by weight and 0.031 kg of cobalt chloride added; the mixture was pasteurised at a temperature of 65°C for 30 minutes, cooled to a temperature of 39°C, and 0.4% by volume of starter culture *(L. acidophilus)* was added. After 3 hours, 1.5% by volume of a culture of propionic acid bacteria was added.

The mixture of microorganisms was cultured

for 22 hours at a temperature of 31°C. The pH value of the fermented whey was adjusted to 6.9. The milk base was prepared by condensing 6500 kg of skim milk to a dry solids content of 35% by weight. The fat base was prepared by adding 50 kg of a 25% solution by weight of sodium caseinate in skim milk, 0.1 kg of a preparation of vitamin A, and 0.05 kg of a preparation of vitamin D to 200 kg of melted fat. The milk base and fat base were thoroughly mixed and then added to the fermented whey; the resulting mixture was homogenised and then spray dried.

The dry whole milk substitute was a fine powder of uniform composition; the solubility index expressed in ml of a wet residue did not exceed 0.8. One gram of the dry product contained $5 \times 10^6$ live cells of acidophilic bacteria and 5 $\mu$g of vitamin $B_{12}$.

*Example 5*

To produce 1 tonne of whole milk substitute, 1420 kg of whey was condensed to a dry solids content of 20% by weight and 0.036 kg of cobalt chloride added; the mixture was fasteurised, cooled to a temperature of 39°C, and 0.5% by volume of starter culture *(L. acidophilus)* was added. After 4 hours, 2.5% by volume of a culture of propionic acid bacteria was added.

The mixture of microorganisms was cultured for 20 hours at a temperature of 32°C. The pH of the fermented whey was adjusted to 7.0. The milk base was prepared by condensing 1120 kg of skim milk to a dry solids content of 40% by weight. The fat base was prepared by adding 12 kg of phosphatide concentrates, 5 kg of distilled monoglycerides, 0.1 kg of a preparation of vitamin A, and 0.05 kg of a preparation of vitamin D to 160 kg of melted fat. The milk base and fat base were thoroughly mixed and then added to the fermented whey; the resulting mixture was homogenised and then spray dried.

The dry whole milk substitute obtained was a fine powder of uniform composition; the solubility index expressed in ml of a wet residue did not exceed 0.8. One gram of the dry product contained $4 \times 10^6$ live cells of acidophilic bacteria and 6 $\mu$g of vitamin $B_{12}$.

CLAIMS

1. A method of preparing a dry whole milk substitute suitable for young farm animals, which comprises adding from 0.4 to 0.6% by volume of acidophilic bacteria to pasteurised whey and fermenting the whey at a temperature of from 37° to 39°C, adding from 1.5 to 2.5% by volume of propionic acid bacteria and further fermenting the whey at a temperature of from 30° to 32°C, neutralising the fermented whey, mixing the neutralised whey with a condensed milk base and a fat base containing fat-soluble vitamins, and homogenising and drying the mixture.

2. A method according to claim 1, in which the whey is condensed to a dry solids content of 15% to 20% by weight prior to fermentation.

3. A method according to claim 1 or 2, in which the acidophilic bacteria is *Lactobacillus acidophilus*.

4. A method according to any of claims 1 to 3, in which the propionic acid bacteria is *Propionobacterium shermanii*.

5. A method of preparing a dry whole milk substitute, substantially as herein described in any of the Examples.

6. A whole milk substitute when made by the method claimed in any of the preceding claims.

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